Knittel, Janette

From: Hale, Elly
Sent: Friday, April 02, 2021 5:17 PM
To: Knittel, Janette; Rick Thomas (RITH461@ECY.WA.GOV)
Subject: FW: Duwamish Section B - Final Data Report and SDM
Attachments: Duwamish Section B_Data Report_Final_29Mar2021.docx

Categories: FOIA, RP: LDW/BP2, Print or Save

FYI – looks like the COE is proposing to dredge the channel near Slip 6 and Rhone Poulenc.

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Sent: Friday, April 2, 2021 5:16 PM
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Subject: FW: Duwamish Section B - Final Data Report and SDM

Hi, Kathy and Susie – You might be aware of this, but just in case, here's some pretty fresh data from the navigation channel near Delta Marine, Rhone Poulenc and Slip 6.

Not sure if they plan to dredge this fall or another year entirely. Given the fish window, I assume they won't be out there when you're collecting Phase 2 data this summer.

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DUWAMISH WATERWAY SECTION B
DREDGED MATERIAL CHARACTERIZATION
SEATTLE, WASHINGTON

CONTRACT W912DW19D1031, DELIVERY ORDER W912DW20F2069

DATA REPORT
FINAL

MARCH 29, 2021

Prepared for:

U.S. Army Corps of Engineers, Seattle District
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Seattle, Washington 98134

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ACRONYMS AND ABBREVIATIONS

ALS	ALS Environmental
BT	bioaccumulation trigger
CAB	cellulose acetate butyrate
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDX	collective reference for DDT, DDE, and DDD
DGPS	differential global positioning system
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
EIM	Environmental Information Management
EMPC	estimated maximum possible concentration
EPA	U.S. Environmental Protection Agency
ESRI	Environmental Systems Research Institute
HPAH	high molecular weight polycyclic aromatic hydrocarbon
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MDL	method detection limit
ML	maximum level
MLLW	Mean Lower Low Water
MS	matrix spike
MSD	matrix spike duplicate
NAD83	North American datum 1983
NOAA	National Oceanic and Atmospheric Administration
NGS	NewFields Government Services
OPR	ongoing precision and recoveries
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PS-SRM	Puget Sound Sediment Reference Material
QA	quality assurance
QC	quality control
RL	reporting limit
RPD	relative percent difference
R/V	research vessel
RSS	Research Support Services, Inc.
SAP	Sampling and Analysis Plan
SL	screening level
SVOC	semi-volatile organic compound
TEQ	toxicity equivalence
TOC	total organic carbon
TVS	total volatile solid
USACE	U.S. Army Corps of Engineers, Seattle District

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Seattle District (USACE) is responsible for maintenance dredging of the Lower Duwamish Waterway, a part of the Seattle Harbor Federal Navigation Project in Seattle, Washington. The USACE proposes to maintenance dredge the portion of the waterway referred to as "Section B," which extends from station 242+00 to 254+00 (Figure 1). The authorized depth of the channel in this area is –15 feet mean lower low water (MLLW). The authorized channel bottom width is 150 feet. The Lower Duwamish Waterway, including the federal navigation channel, has been on the U.S. Environmental Protection Agency (EPA) Superfund list since 2001.

This document provides the results of the December 2020 dredged material characterization of the Duwamish Waterway Section B conducted by the USACE. Dredging is likely to occur in the 2022 dredging year in coordination with dredging of other portions of the Lower Duwamish Waterway. This characterization study was conducted following the Duwamish Waterway Section B Dredged Material Characterization Sampling and Analysis Plan (SAP) (Appendix A, NewFields 2020). The SAP described the overall study design, sediment collection methods, dredged material management unit (DMMU) designations, proposed sampling locations, analytical testing requirements, and data reporting.

The following sections provide a brief description of the sample collection methods, modifications or deviations to the sampling plan, a summary of the actual sampling locations and depths, the results of the chemical analysis, a comparison of the data results to Dredged Material Management Program (DMMP) guidelines, and a summary of quality control (QC) data for conventional and chemistry testing, including validation results. Biological testing was not required for this characterization.

The full list of appendices include: the final DMMP-approved SAP (Appendix A); the field logbook, core logs, and core photographs (Appendix B, electronic copy only); the analytical laboratory reports and chain-of-custody forms (Appendix C, electronic copy only); data validation reports (Appendix D); the results of chemical analyses reported in Environmental Information Management (EIM) format (Appendix E, electronic copy only); and Environmental Systems Research Institute (ESRI) geodatabase files which include DMMU boundaries, target locations, and actual sampling locations (Appendix F, electronic copy only).

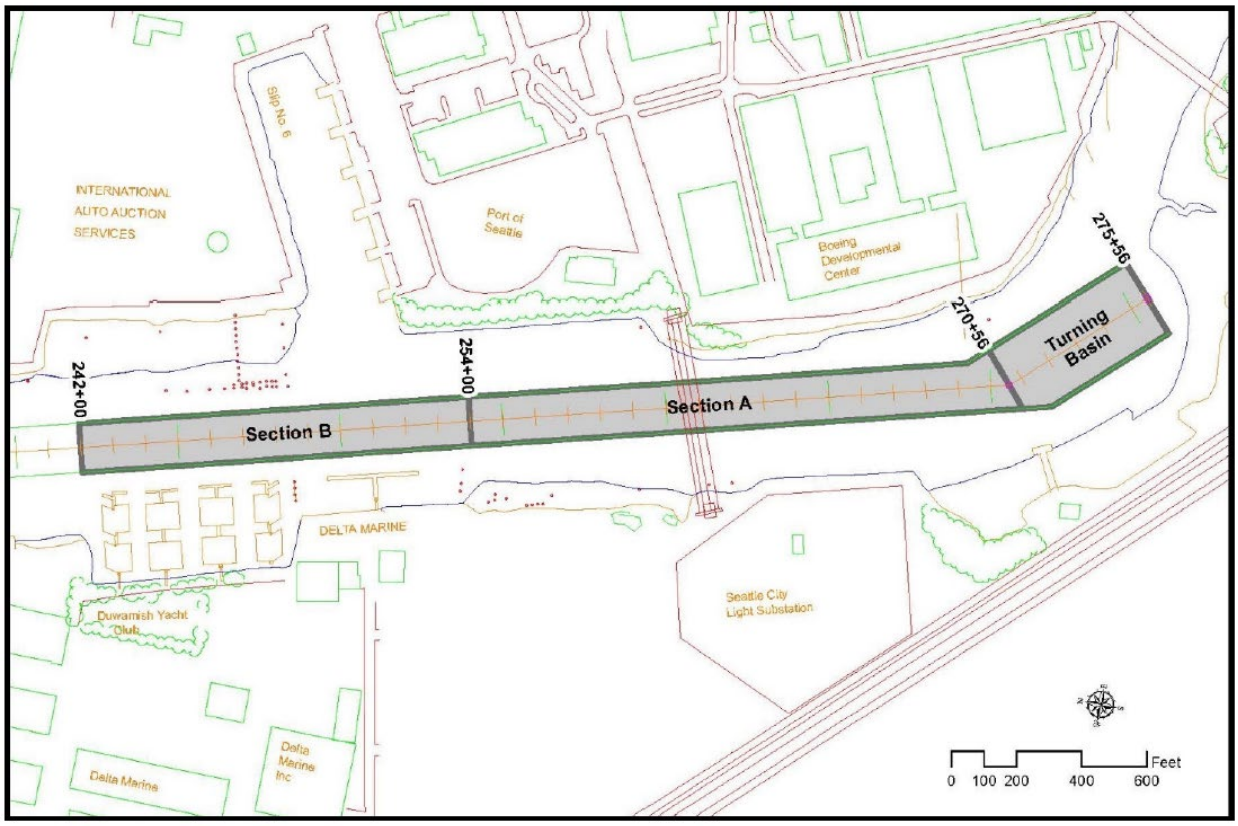

Figure 1. Proposed USACE Dredging Area - Duwamish Waterway, Section B

1.1 Project Overview

The depth to be characterized in the Duwamish Waterway Section B included the authorized project depth (–15 ft. MLLW), two feet of overdepth (to –17 ft. MLLW), plus the Z-layer (–17 to –19 ft. MLLW). The overdepth was one foot deeper than previously used for Section B (DMMP 2018a). The sediment was also considered heterogeneous based on the elevated dioxin concentration at depth, observed in 2009 (DMMP 2009).

The USACE conducted a bathymetric survey of Section B of the Duwamish Waterway in October 2020 to determine the current volume of maintenance material. Including overdepth, the volume estimate was 13,520 cubic yards (cy) and limited to surface (0-4 ft.) DMMUs. To account for sediment accumulation prior to dredging in the 2022 dredging year, a contingency factor of 44 percent was added for a total estimated volume of 24,000 cy of material for characterization (Table 1).

Section B of the Duwamish Waterway is ranked high according to the DMMU User Manual ranking guidelines (DMMP 2018b). Under a high project ranking, a sample is required for every 4,000 cy of material, and the maximum volume of sediment represented by each surface DMMU is 4,000 cy. Therefore, a total of six sediment core locations were proposed to characterize six DMMUs in Section B (Figure 2).

Table 1. Duwamish Waterway Section B Project Characteristics Summary

DMMU	Area (acres)	Estimated Volume (cy) to Authorized Depth (−15 ft. MLLW)		Estimated Volume (cy) of 2 ft. Overdepth (−15 to −17 ft. MLLW)	Contingency Volume (cy)	Total Volume (cy)
		Nav Channel	Slopes			
DMMU1	0.69	96	119	2,183	1,602	**4,000**
DMMU2	0.69	386	11	2,232	1,371	**4,000**
DMMU3	0.69	178	52	2,224	1,546	**4,000**
DMMU4	0.69	86	52	2,052	1,810	**4,000**
DMMU5	0.69	81	36	1,727	2,156	**4,000**
DMMU6	0.69	26	13	1,965	1,996	**4,000**
Total Volumes (cy):		**853**	**283**	**12,383**	**10,481**	**24,000**

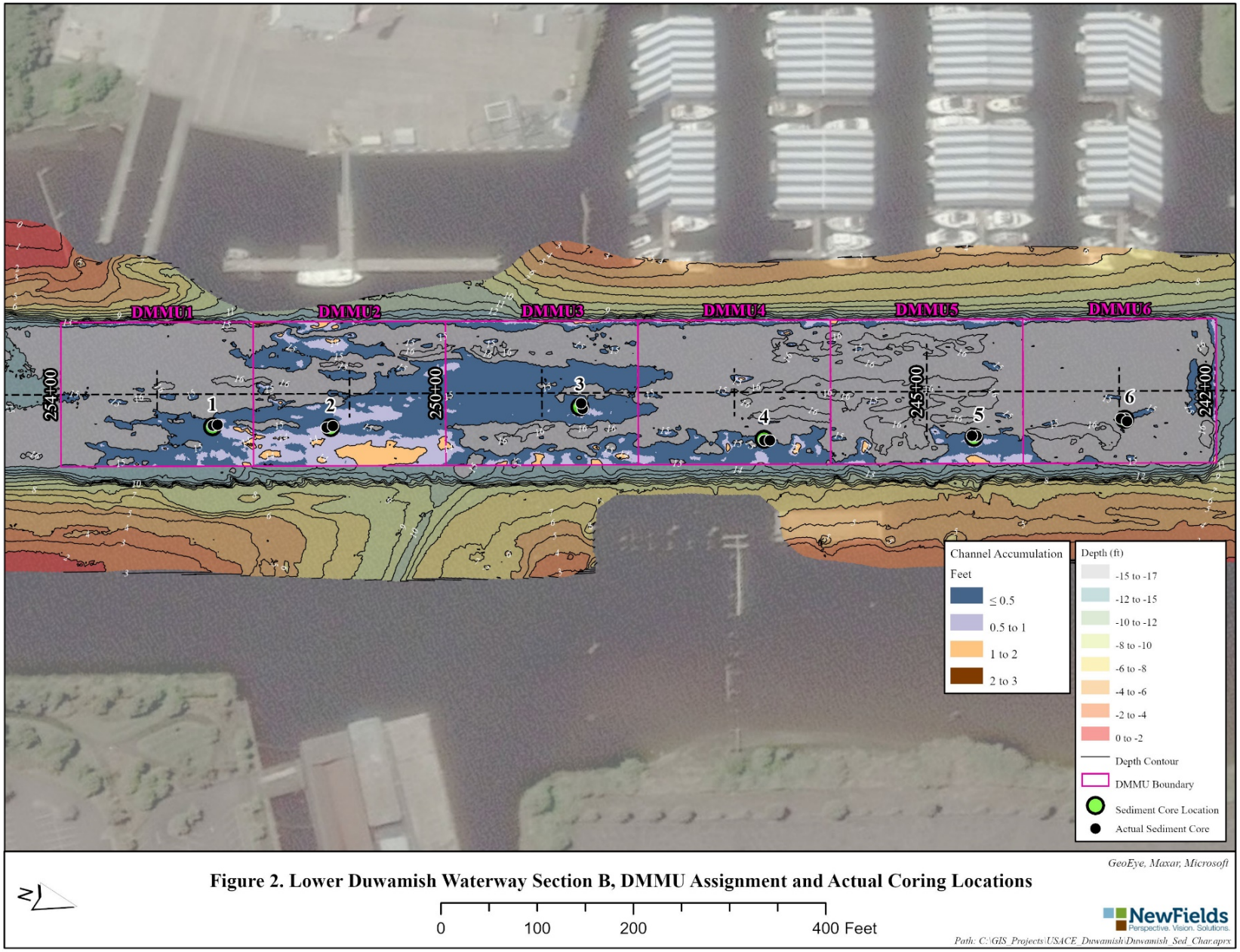

Figure 2. Lower Duwamish Waterway Section B, DMMU Assignment and Actual Coring Locations

2.0 Data Collection and Analysis Methods

This section provides an overview of the methods used for vessel positioning, sample collection, sediment processing, and laboratory analysis for the Duwamish Waterway Section B sediment characterization. The study design and detailed methods are provided in the SAP (Appendix A). Deviations from the SAP are summarized in Section 2.7.

2.1 Sampling Overview

Sediment sampling activities were conducted in the Duwamish Waterway on December 9 and 10, 2020. The research vessel (R/V) *Carolyn Dow*, owned and operated by Research Support Services (RSS), was the platform used for the sediment core collection. Sediment cores were collected using a Rossfelder vibracore sampler provided by RSS.

Following collection, vibracores were transferred to shore and transported to the NewFields Government Services (NGS) office in Edmonds, WA, for processing, compositing, and sample collection. Personnel from NGS were responsible for evaluating, compositing, and transferring sediment samples to appropriate containers on shore, while personnel from RSS and Herrera Environmental Consultants (Herrera) operated the vibracorer and measured water depth and core penetration under the direction of the NGS field lead.

2.2 Navigation and Positioning

Geographic station positioning was accomplished using an onboard Differential Global Positioning System (DGPS) with the antenna for the onboard DGPS receiver located on the sampler deployment A-frame. The mudline elevation at each sampling location was determined using a lead line. Real-time tidal corrections were applied using water level measurements from the National Oceanic and Atmospheric Administration (NOAA) Seattle, WA tide station (Station ID: 9447130). Details regarding navigation and positioning methods are provided in the SAP (Appendix A).

The actual sampling coordinates, DMMU sample identifications, water depths (with tidal stage), and mudline elevations are provided in Table 2. Figure 2 displays the DMMU configurations and actual sampling locations in Duwamish Waterway Section B. All retained vibracores were collected within 10 feet (3 meters) of target sampling locations.

2.3 DMMUs and Sampling Locations

Section B of the Duwamish Waterway has a high project ranking, which required a sample for every 4,000 cy of material. The maximum volume of sediment represented by each surface DMMU was 4,000 cy. A total of six sediment core locations were proposed to characterize six DMMUs in Section B (Figure 2).

Individual archives of each Z-sample were also retained for potential chemical or biological analysis. To demonstrate that the new leave surface complied with Washington State's antidegradation standard, a Z-layer sample was also collected from each sediment core and composited into one analytical sample that represented the new surface layer.

Each vibracore was advanced to –19 ft MLLW to characterize the authorized project depth (–15 ft MLLW), two feet of overdepth (to –17 ft MLLW), and the Z-layer (–17 to –19 ft MLLW). Except for location D6, two vibracores were collected at each location to acquire the volume of sediment needed for chemical analysis and potential biological testing for each DMMU and Z-layer sample. Three vibracores were collected at D6 to collect adequate sediment volume for surface composite sample DMMU6.

2.4 Sample Collection Methods

A summary of the sample collection methods is provided in this section. The detailed methods are described in the SAP (Appendix A).

2.4.1 Vibracore Samples

Core samples were collected using RSS' Rossfelder vibracorer using pre-cleaned cellulose acetate butyrate (CAB) liners inside a stainless-steel tube. The core tubes were 4 inches in diameter.

The vibracore was mechanically lowered into position on the seafloor, activated, and allowed to penetrate to the target sampling depth or refusal. An integrated measurement tape was used to monitor real-time depth penetration of the corer head. Once sampling was complete, the vibracore was retrieved and the core liner removed from the core tube. The condition and quantity of material within the core was then inspected to determine acceptability. If a core was deemed acceptable, the core tube was capped on both ends, secured with duct tape, and labeled with the station and replicate number. A sediment recovery of at least 75 percent of the penetration depth was achieved for each retained core.

Core samples were taken to shore and transported to the NGS Edmonds, WA, office for processing. Cores were transported by truck and secured in an upright position. The overlying water was decanted from each core and the CAB liner was split in half using powered shears. The sediment was then split lengthwise using a pre-cleaned stainless-steel spatula. Once opened, the sediment was inspected, described, and photographed. Core logs and photographs are provided in Appendix B.

Cross-sectional cuts were made along the core at the appropriate depths for the DMMU and Z-samples. Depth-proportional volumes of sediment were removed from each core interval comprising a DMMU composite. In other words, approximately equal volumes of sediment were removed along the length of each foot of core. Sediment was collected from throughout the entire acceptable sample, except for sediment coming in direct contact with the sampling equipment.

A minimum of two core samples was collected from the same location in each DMMU to collect the required sediment volume needed for chemical and potential biological testing for both the DMMU and Z-sample. A Z-layer composite (consisting of all six Z-samples) was also collected for the analysis of total solids, total organic carbon (TOC), dioxins/furans, and polychlorinated biphenyl (PCB) Aroclors (Table 3). The core intervals required for each DMMU and Z-sample were collected and processed on the same day. Sediment retained for the Z-layer composite after the first day of processing was placed in a polyethylene bag, labeled, sealed with limited

Table 2. DMMUs, Sample Locations, Actual Sampling Coordinates, Mudline, and Sample Elevations

Surface DMMU	Sample Location	Core Replicate	Date (mm/dd/yyyy)	Time (hh:mm)	State Plane WA-N, NAD83		Latitude (N) NAD83	Longitude (W) NAD83	Core Penetration (ft.)	Core Recovery (ft.)	Recovery (percent)	Measured Water Depth (ft.)	Tidal Height (ft.)	Mudline (ft. MLLW)	Surface DMMU (ft. MLLW)		Z-sample (ft. MLLW)	
					Northing	Easting									Top	Bottom	Top	Bottom
DMMU1	D1	1	12/10/2020	11:15	192381.5	1276547.2	47.517865	–122.305968	4.6	4.2	91	–25.4	10.8	–14.6	–14.6	–17.0	–17.0	–18.8
	D1	2	12/10/2020	11:40	192386.0	1276545.3	47.517878	–122.305976	5.1	5.1	100	–25.1	11.2	–13.9	–13.9	–17.0	–17.0	–19.0
DMMU2	D2	1	12/10/2020	10:10	192496.9	1276521.2	47.518180	–122.306082	4.7	4.2	88	–23.1	8.8	–14.3	–14.3	–17.0	–17.0	–18.5
	D2	2	12/10/2020	10:30	192502.5	1276518.1	47.518196	–122.306095	4.4	4.4	100	–24.1	9.4	–14.7	–14.7	–17.0	–17.0	–19.0
DMMU3	D3	1	12/10/2020	9:00	192750.6	1276439.5	47.518872	–122.306432	4.4	4.4	100	–21.3	6.5	–14.8	–14.8	–17.0	–17.0	–19.0
	D3	2	12/10/2020	9:30	192748.0	1276434.3	47.518864	–122.306453	4.2	4.0	95	–22.3	7.5	–14.8	–14.8	–17.0	–17.0	–18.8
DMMU4	D4	1	12/09/2020	14:10	192941.9	1276426.9	47.519395	–122.306498	5.8	6.0	103	–23.4	10.0	–13.4	–13.4	–16.8	–16.8	–18.8
	D4	2	12/09/2020	14:50	192947.5	1276425.2	47.519410	–122.306505	6.0	5.4	90	–22.5	9.1	–13.4	–13.4	–16.8	–16.8	–18.8
DMMU5	D5	1	12/09/2020	12:20	193155.0	1276369.9	47.519976	–122.306745	5.1	5.0	98	–25.9	11.8	–14.1	–14.1	–17.1	–17.1	–19.1
	D5	2	12/09/2020	12:43	193150.4	1276371.0	47.519964	–122.306740	5.3	5.2	98	–25.7	11.7	–14.0	–14.0	–17.0	–17.0	–19.0
DMMU6	D6	1	12/09/2020	10:04	193301.4	1276315.8	47.520375	–122.306975	4.3	4.4	102	–25.7	10.0	–15.7	–15.7	–17.4	–17.4	–19.4
	D6	2	12/09/2020	11:10	193296.8	1276317.0	47.520362	–122.306970	4.5	4.9	108	–26.8	11.3	–15.5	–15.5	–17.0	–17.0	–19.0
	D6	3	12/09/2020	11:40	193303.8	1276318.4	47.520381	–122.306965	4.0	4.1	102	–27.1	11.7	–15.4	–15.4	–16.8	–16.8	–18.8

NAD83 North American Datum 1983

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headspace and stored overnight at 4±2°Celsius in the NGS Edmonds, WA, sample refrigerator. The Z-layer composite sample was completed on the second day of processing.

Following completion of core processing, samples for conventional and chemical analyses were packed in coolers on ice and hand-delivered to the analytical laboratory accompanied by a chain-of-custody record (Appendix C). Sediment samples for potential bioassay testing were archived at 4±2°Celsius at the NGS Edmonds, WA, office.

Excess sediment from core processing was retained in polyethylene bags in 5-gallon buckets and stored in the NGS Edmonds, WA, storage area. Sediments were properly disposed following receipt of the analytical laboratory results.

2.5 Chemical Analytical Methods

Sediment sample preparation methods, analytical methods, and target reporting limits (RLs) are discussed in detail in the SAP (Appendix A). All samples were analyzed by ALS Environmental (ALS), Kelso, Washington.

The Kelso laboratory performed all analyses with exception of organochlorine pesticides and dioxins/furans, which were analyzed by ALS in Burlington, Ontario, Canada. The organochlorine pesticides were analyzed using EPA Method 1699, which provided lower reporting limits than Method 8081. A list of samples collected and analyzed for DMMP chemicals of concern is provided in Table 3.

2.6 Biological Testing Methods

The SAP (Appendix A) provided a description of methods for bioassay testing (larval development, amphipod mortality, and juvenile polychaete growth) if triggered under the DMMP tiered testing approach (DMMP 2018b). All detected and undetected chemical concentrations fell below DMMP SLs. Therefore, bioassay testing was not required.

2.7 Summary of Data Collection Activities and Deviations from SAP

This section provides a summary of the daily sampling and processing activities, as well as any deviations from the field sampling or laboratory objectives, which were proposed in the SAP (Appendix A).

2.7.1 Daily Sampling Activities

Day 1 (12/9/2020): Core sampling activities aboard the R/V *Carolyn Dow* were initiated in the Duwamish Waterway Section B. Weather conditions were calm with overcast skies. Three sediment cores were collected at D6, two sediment cores were collected at D5, and two sediment cores were collected at D4. Cores were offloaded from the vessel and transported to the NGS Edmonds, WA, office for processing. All cores collected on Day 1 were processed, and samples were collected for DMMU4, DMMU5, and DMMU6, and Z-samples D4-Z, D5-Z, and D6-Z. Sediment required for the Z-layer composite sample (ZLAYER-C) was retained and archived overnight.

Day 2 (12/10/2020): Core sampling activities continued in the Duwamish Waterway Section B. Weather conditions continued to be calm with overcast skies. Two sediment cores were

collected at D3, two sediment cores were collected at D2, and two sediment cores were collected at D1. Core samples were offloaded and transported to the NGS Edmonds, WA, office for processing. All cores collected on Day 2 were processed, and samples were collected for DMMU1, DMMU2, and DMMU3, and Z-samples D1-Z, D2-Z, and D3-Z. The remaining sediment required for the Z-layer composite was collected and sample ZLAYER-C was completed.

2.7.2 Deviations from SAP

Deviations from the SAP included three that occurred during core sample processing and one related to the reporting of benzoic acid results from the analytical laboratory.

- The depth of the surface DMMU sample for four cores was not measured exactly to the target elevation of –17.0 ft MLLW due to a slight mathematical error during core processing. The DMMU sample from the two cores from D4 and the third core from D6 were collected to –16.8 feet MLLW, which was 0.2 ft short of the target elevation. The surface DMMU sample from the first core from D6 was collected to –17.4 ft MLLW, which was 0.4 ft deeper than the target elevation. These slight discrepancies with the surface DMMU bottom elevations were not believed to have affected the chemical results obtained for samples DMMU4 and DMMU6. Chemical analysis of the underlying Z-layer composite (consisting of all six Z-samples) was also conducted.
- Due to a transcription error in the field, an incorrect water depth was recorded on the core log for the first core collected from D5. The mudline elevation was recorded at –14.0 ft MLLW instead of –14.1 ft MLLW. The surface sample collected from the first core from D5 was collected to –17.1 ft MLLW, which was 0.1 ft deeper than the target elevation. This slight discrepancy was not believed to have affected the chemical results obtained for sample DMMU5.
- A photograph of the Z-layer for the second core collected at station D2 was not obtained.
- The SAP specified reporting of SVOC analytical results to the RLs except for 2,4-dimethyl phenol, which was reported to the method detection limit (MDL). Benzoic acid was undetected in all samples, but the RL provided by the analytical laboratory was elevated and exceeded the DMMP SL. The elevated RL was due to the laboratory method/instrument's low response factor rather than due to matrix interference. Reporting to the MDL was the lowest option that the analytical laboratory could provide for this compound. This issue was discussed with the Dredged Material Management Office (DMMO) representative and it was agreed that reporting the benzoic acid results to the MDL was appropriate.

Table 3. Summary of Duwamish Waterway Section B Samples Submitted for Chemical Analysis

Sample Delivery Group	Sample ID	Lab ID	Grain Size	Total Solids	Total Volatile Solids (TVS)	Total Organic Carbon (TOC)	Ammonia	Total Sulfides	Metals & Mercury	SVOCs	Pesticides	PCB Aroclors	Dioxin/Furan Congeners
K2011635	DW20-DMMU1	K2011635-04		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-04	X										
K2011635	DW20-DMMU2	K2011635-05		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-05	X										
K2011635	DW20-DMMU3	K2011635-06		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-06	X										
K2011635	DW20-DMMU4	K2011635-03		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-03	X										
K2011635	DW20-DMMU5	K2011635-01		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-01	X										
K2011635	DW20-DMMU6	K2011635-02		X	X	X	X	X	X	X	X	X	X
K2100358		K2100358-02	X										
K2011635	DW20-ZLAYER-C	K2011635-07		X	X	X						X	X

Notes:
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compounds

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3.0 RESULTS

This section presents the validated analytical chemistry results for the Duwamish Waterway Section B characterization. Table 4 summarizes the DMMP conventional and chemistry results for each DMMU sample, and the total solids, TVS, TOC, grain size, PCBs, and dioxins/furans results for the Z-layer sample. Table 5 provides the total toxic equivalent (TEQ) calculations for the dioxin/furan congener results. Chain of custody forms and laboratory reports are provided in Appendix C.

Herrera performed third-party data validation (EPA Stage 2B) on all chemistry data and EcoChem, Inc. performed EPA Stage 4 validation on the dioxin/furan congener data (Appendix D). Laboratory and validation data qualifiers are defined in the footnotes to Table 4.

Several chemical groups are represented by a total concentration, including low molecular weight polycyclic aromatic hydrocarbons (LPAHs), high molecular weight polycyclic aromatic hydrocarbons (HPAHs), total dichlorodiphenyltrichloroethane (DDT), chlordane, and PCBs. Total concentrations were calculated by summing detected results. If all results were undetected, then the maximum RL of any constituent was reported.

No results in Table 4 exceeded the DMMP screening level (SL), maximum level (ML), or bioaccumulation trigger (BT). Therefore, no results have been highlighted.

3.1 Sediment Description

Surface sediments within the Duwamish Waterway Section B consisted primarily of unconsolidated, bluish-black, organic-rich silts and clays with some interbedded layers of fine sand. Fine plant material was present in most cores, and small scattered woody debris was observed at stations D1, D2, and D5. Sediments in the Z-layer consisted of sandy silts and clays, and consolidation increased with depth.

3.2 Sediment Conventionals

The sediment conventional parameters were generally similar across all DMMUs and the Z-layer sample (Table 4). Grain size consisted predominantly of silt, ranging from 48.9 percent at DMMU6 to 60.1 percent at DMMU5, with an average of 52.6 percent (±4.7 percent, n=6) for all DMMUs. The Z-layer composite sample (ZLAYER) was similar with 51.4 percent silt. TOC averaged 2.7 percent for all DMMUs and was similar to TOC in the ZLAYER sample at 2.67 percent.

Total sulfides were relatively high in all DMMU samples, ranging from 2,240 mg/kg at DMMU6 to 3,800 mg/kg at DMMU5, with an average of 3,273 mg/kg (± 608 mg/kg, n=6). Ammonia ranged from 58.3 mg/kg at DMMU6 to 120 mg/kg at DMMU4, with an average of 83 mg/kg (±22 mg/kg; n=6).

3.3 Metals

The metals concentrations in Duwamish Waterway Section B sediments were similar across all DMMUs. All metals were detected but were well below the DMMP SLs (Table 4).

3.4 Semi-Volatile Organic Compounds

The LPAHs were undetected except for phenanthrene detected at low concentrations in all DMMUs, and anthracene measured at estimated (J-qualified) concentrations in DMMU2 and DMMU4. All HPAHs were detected at low concentrations with the exception of dibenzo(a,h)anthracene, which was undetected. All polycyclic aromatic hydrocarbons (PAHs) were below the DMMP SLs.

All chlorinated hydrocarbons, phthalates, phenols, and miscellaneous extractables were undetected except for estimated concentrations of di-n-butyl phthalate in DMMU1, bis(2-ethylhexyl) phthalate in all DMMUs, di-n-octyl phthalate in DMMU5, phenol in all DMMUs, and 4-methylphenol in DMMU6.

All SVOCs were undetected or detected at low concentrations below the DMMP SLs (Table 4).

3.5 Pesticides and PCBs

All pesticides were undetected or detected at very low concentrations below the DMMP SLs (Table 4). Low reporting limits were achieved for pesticides using EPA Method 1699. Total PCBs were measured in all DMMUs ranging from 41 µg/kg at DMMU1 and DMMU6, to 51 µg/kg at DMMU3 and DMMU4. The ZLAYER sample had a similar concentration of 50 µg/kg. Total PCBs were below the DMMP SL for all samples.

3.6 Dioxins/Furans

The total TEQ for dioxins/furans for the Duwamish Waterway Section B DMMUs ranged from a low of 0.499 ng/kg (ND=0) and 0.821 ng/kg (ND=1/2 DL) at DMMU3, to a high of 2.08 ng/kg (ND=0) and 2.30 ng/kg (ND=1/2 DL) at DMMU6. The ZLAYER sample had a total TEQ of 0.671 ng/kg (ND=0) and 0.960 ng/kg (ND=1/2 DL). All samples were below the DMMP SL of 4.0 ng/kg TEQ.

3.7 Puget Sound Sediment Reference Material Results

The laboratory extracted and analyzed the Puget Sound Sediment Reference Material (PS-SRM) as part of analytical batch K2011635 (Table 6). The laboratory used a smaller sample size than the standard, resulting in elevated reporting limits (RLs) and some congeners reported as not detected. The guidance limit for dioxin/furan congeners was 50%-150% and the acceptance range for Aroclor 1260 was 41-180 µg/kg (DMMP 2018b).

The EPA Level 4 validation noted the following outlier for analytical batch K2011635:

- The recovery for 1,2,3,7,8,9-HxCDF was greater than the upper control limit, however the true value was less than the RL. No action was taken on this basis. All other detected values and reported estimated maximum possible concentrations (EMPCs) were within the control limits.

Table 4. Sediment Chemistry Results

Compound	Units	DMMP SL	DMMP BT	DMMP ML	DW20-DMMU1 Results	DW20-DMMU1 VQ	DW20-DMMU2 Results	DW20-DMMU2 VQ	DW20-DMMU3 Results	DW20-DMMU3 VQ	DW20-DMMU4 Results	DW20-DMMU4 VQ	DW20-DMMU5 Results	DW20-DMMU5 VQ	DW20-DMMU6 Results	DW20-DMMU6 VQ	DW20-ZLAYER-C Results	DW20-ZLAYER-C VQ
Conventionals																		
Total Solids	%	---	---	---	51.0		53.2		54.9		50.7		50.2		53.6		55.0	
Total Volatile Solids	%	---	---	---	7.50		7.50		6.80		7.80		7.90		7.00		7.40	
Total Organic Carbon	%	---	---	---	2.91		2.74		2.39		2.97		2.85		2.34		2.67	
Total Sulfides	mg/kg	---	---	---	3300		2900		3700		3700		3800		2240			
Ammonia	mg/Kg	---	---	---	88.5		73.7		66.1		120		90.6		58.3			
Gravel	%	---	---	---	0.0		0.05		0		0		0.08		0		0	
Sand	%	---	---	---	35.0		34.6		42.2		27.3		28.8		38.9		33.6	
Silt	%	---	---	---	51.7		51.6		47.5		60.1		55.8		48.9		51.4	
Clay	%	---	---	---	10.7		9.5		6.3		8.1		10.3		8.9		11.6	
Grain Size (Fines)	%	---	---	---	62.4		61.1		53.8		68.2		66.1		57.8		63.0	
Metals and Metalloid																		
Antimony	mg/kg	150	---	200	0.204		0.198		0.169		0.247		0.169	J	0.322			
Arsenic	mg/kg	57	507.1	700	10.5		9.84		8.69		11.4		10.6		8.85			
Cadmium	mg/kg	5.1	---	14	0.229		0.226		0.205		0.262		0.234		0.214			
Chromium	mg/kg	260	---	---	24.4		23.3		21.4		24.9		23.9		22.0			
Copper	mg/kg	390	---	1,300	34.3		33.7		29.1		36.4		35.7		31.4			
Lead	mg/kg	450	975	1,200	13.1		13.0		11.8		14.3		13.3		12.1			
Mercury	mg/kg	0.41	1.5	2.3	0.087		0.105		0.099		0.104		0.102		0.078			
Selenium	mg/kg	---	3	---	0.44	J	0.39	J	0.35	J	0.46	J	0.42	J	0.37	J		
Silver	mg/kg	6.1	---	8.4	0.123		0.103		0.096		0.115		0.112		0.097			
Zinc	mg/kg	410	---	3,800	82.8		79.8		71.4		83.8		82.4		73.1			
Organics																		
PAHs																		
Naphthalene	ug/kg	2,100	---	2,400	19	U	18	U	18	U	19	U	20	U	18	U		
Acenaphthylene	ug/kg	560	---	1,300	19	U	18	U	18	U	19	U	20	U	18	U		
Acenaphthene	ug/kg	500	---	2,000	19	U	18	U	18	U	19	U	20	U	18	U		
Fluorene	ug/kg	540	---	3,600	19	U	18	U	18	U	19	U	20	U	18	U		
Phenanthrene	ug/kg	1,500	---	21,000	23		24		24		23		23		19			
Anthracene	ug/kg	960	---	13,000	19	U	6.5	J	18	U	6.6	J	20	U	18	U		
2-Methylnaphthalene	ug/kg	670	---	1,900	19	U	18	U	18	U	19	U	20	U	18	U		
Total LPAH	ug/kg	5,200	---	29,000	23		30.5		24		23		23		19			
Fluoranthene	ug/kg	1,700	4,600	30,000	60		59		59		77		65		45			
Pyrene	ug/kg	2,600	11,980	16,000	43		52		49		61		53		37			
Benzo(a)anthracene	ug/kg	1,300	---	5,100	24		27		24		26		28		19			
Chrysene	ug/kg	1,400	---	21,000	37		41		33		64		41		29			
Benzofluoranthenes	ug/kg	3,200	---	9,900	58	J	61	J	58	J	72	J	66	J	45	J		
Benzo(a)pyrene	ug/kg	1,600	---	3,600	26		30		28		29		31		20			
Indeno(1,2,3-c,d)pyrene	ug/kg	600	---	4,400	29		28		27		31		28		19			
Dibenzo(a,h)anthracene	ug/kg	230	---	1,900	19	U	18	U	18	U	19	U	20	U	18	U		
Benzo(g,h,i)perylene	ug/kg	670	---	3,200	20		24		19		25		23		13	J		
Total HPAH	ug/kg	12,000	---	69,000	297		322		297		385		335		227			
Chlorinated Hydrocarbons																		
1,4-Dichlorobenzene	ug/kg	110	---	120	19	U	18	U	18	U	19	U	20	U	18	U		

Compound	Units	DMMP SL	DMMP BT	DMMP ML	DW20-DMMU1 Results	DW20-DMMU1 VQ	DW20-DMMU2 Results	DW20-DMMU2 VQ	DW20-DMMU3 Results	DW20-DMMU3 VQ	DW20-DMMU4 Results	DW20-DMMU4 VQ	DW20-DMMU5 Results	DW20-DMMU5 VQ	DW20-DMMU6 Results	DW20-DMMU6 VQ	DW20-ZLAYER-C Results	DW20-ZLAYER-C VQ
1,2-Dichlorobenzene	ug/kg	35	---	110	19	U	18	U	18	U	19	U	20	U	18	U		
1,2,4-Trichlorobenzene	ug/kg	31	---	64	19	U	18	U	18	U	19	U	20	U	18	U		
Hexachlorobenzene	ug/kg	22	168	230	19	U	18	U	18	U	19	U	20	U	18	U		
Phthalates																		
Dimethyl phthalate	ug/kg	71	---	1,400	19	U	18	U	18	U	19	U	20	U	18	U		
Diethyl phthalate	ug/kg	200	---	1,200	19	U	18	U	18	U	19	U	20	U	18	U		
Di-n-butyl phthalate	ug/kg	1,400	---	5,100	43	J	22	U	27	U	24	U	39	U	11	U		
Butyl benzyl phthalate	ug/kg	63	---	970	19	U	18	U	18	U	19	U	20	U	18	U		
Bis(2-ethylhexyl)phthalate	ug/kg	1,300	---	8,300	83	J	110	J	59	J	74	J	96	J	59	J		
Di-n-octyl phthalate	ug/kg	6,200	---	6,200	19	U	18	U	18	U	19	U	20	J	18	U		
Phenols																		
Phenol	ug/kg	420	---	1,200	20	J	8.3	J	7.6	J	37	J	11	J	8.2	J		
2-Methylphenol	ug/kg	63	---	77	19	U	18	U	18	U	19	U	20	U	18	U		
4-Methylphenol	ug/kg	670	---	3,600	19	U	18	U	18	U	19	U	20	U	18	J		
2,4-Dimethylphenol	ug/kg	29	---	210	13	U	12	U	12	U	13	U	13	U	12	U		
Pentachlorophenol	ug/kg	400	504	690	190	U	180	U	180	U	190	U	200	U	180	U		
Miscellaneous Extractables																		
Benzyl alcohol	ug/kg	57	---	870	39	U	37	U	36	U	39	U	40	U	37	U		
Benzoic acid	ug/kg	650	---	760	190	U	180	U	180	U	190	U	190	U	180	U		
Dibenzofuran	ug/kg	540	---	1,700	19	U	18	U	18	U	19	U	20	U	18	U		
Hexachlorobutadiene	ug/kg	11	---	270	0.41	U	0.41	U	0.38	U	0.42	U	0.43	U	0.40	U		
N-Nitrosodiphenylamine	ug/kg	28	---	130	19	U	18	U	18	U	19	U	20	U	18	U		
Pesticides and PCBs																		
4,4'-DDD	ug/kg	16	---	---	0.356	J	0.389	J	0.189	J	0.301	J	0.357	J	0.371	J		
4,4'-DDE	ug/kg	9	---	---	0.453		0.423		0.245	J	0.407	J	0.478		0.379	J		
4,4'-DDT	ug/kg	12	---	---	0.19	U	0.058	U	0.08	U	0.085	U	0.16	U	0.517	J		
Total 4,4'-DDX	ug/kg	---	50	69	0.809		0.812		0.434		0.708		0.835		1.267			
Aldrin	ug/kg	9.5	---	---	0.0085	U	0.0075	U	0.0055	U	0.0064	U	0.0052	U	0.0075	U		
Total Chlordane	ug/kg	2.8	37	---	0.375	J	0.58	J	0.239	J	0.3706	J	0.5575	J	0.147	J		
Dieldrin	ug/kg	1.9	---	1,700	0.131	J	0.193	J	0.076	J	0.158	J	0.189	J	0.166	J		
Heptachlor	ug/kg	1.5	---	270	0.0067	U	0.0051	U	0.0057	U	0.0052	U	0.0059	U	0.011	U		
Total PCBs	ug/kg	130	38‡	3,100	41	J	45		51		51		44		41		50	J
Dioxins/Furans																		
2,3,7,8-TCDF	ng/kg	---	---	---	0.20*	U	0.26	J	0.14	U	0.19*	U	0.308	J	0.26	J	0.14	U
2,3,7,8-TCDD	ng/kg	---	---	---	0.160	U	0.14	U	0.12	U	0.13	U	0.12	U	0.12	U	0.12	U
1,2,3,7,8-PeCDF	ng/kg	---	---	---	0.29	J	0.25	J	0.175		0.266	J	0.338	J	0.25*	U	0.198	J
2,3,4,7,8-PeCDF	ng/kg	---	---	---	0.734	J	0.72	J	0.26*	U	0.576	J	0.64*	U	0.805	J	0.27*	U
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.31*	U	0.37*	U	0.16*	U	0.30*	U	0.39*	U	0.26*	U	0.20*	U
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	1.23	J	0.925		0.49*	U	0.923	J	1.2*	U	1.8	J	0.54	J
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	0.53	J	0.42*	U	0.297	J	0.524	J	0.43*	U	0.6	J	0.30*	U
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	1.57	J	1.46	J	0.815	U	1.23	J	3.61	J	1.86	J	0.47*	UJ
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	0.44	J	0.18*	U	0.11	U	0.16	J	0.12	U	0.61	J	0.19*	U
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	0.79	J	0.75*	U	0.26*	U	0.64*	U	0.60*	U	0.53*	U	0.38	J
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	2.85	J	2.34	J	1.0*	U	1.87	J	2.25	J	2.51	J	1.68	J
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	1.81	J	1.4*	U	0.62	J	1.2*	U	1.76	J	1.5	J	0.66	U
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	9.20	J	8.96	J	5.58	J	8.23	J	11.8		10.6		4.27	J

Compound	Units	DMMP SL	DMMP BT	DMMP ML	DW20-DMMU1 Results	DW20-DMMU1 VQ	DW20-DMMU2 Results	DW20-DMMU2 VQ	DW20-DMMU3 Results	DW20-DMMU3 VQ	DW20-DMMU4 Results	DW20-DMMU4 VQ	DW20-DMMU5 Results	DW20-DMMU5 VQ	DW20-DMMU6 Results	DW20-DMMU6 VQ	DW20-ZLAYER-C Results	DW20-ZLAYER-C VQ
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	0.81	J	0.67*	U	0.52*	U	0.76*	U	1.12	J	1.09	J	0.46	J
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	61.5		55.2		26.9		46.2		57		63.2		28.4	
OCDF	ng/kg	---	---	---	28.9		32.4		26.8		27.6		35.6		29.6		13.9	J
OCDD	ng/kg	---	---	---	531		511		231		411		520		542		232	
Total TEQ (ND = 0)	ng/kg	4	10	---	2.03		1.53		0.499		1.33		1.67		2.08		0.671	
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	2.28		1.92		0.821		1.65		2.14		2.30		0.960	
Total TCDF	ng/kg	---	---	---	2.72		2.6		0.77		3.54		2.35		2.44		0.644	
Total TCDD	ng/kg	---	---	---	0.659		0.184		0.12	U	0.295		0.39		0.12	U	0.12	U
Total PeCDF	ng/kg	---	---	---	3.02		6.5		1.83		5.26		5.57		5.56		2.90	
Total PeCDD	ng/kg	---	---	---	1.64		1.13		0.81		0.10	U	1.45		1.54		0.848	
Total HxCDF	ng/kg	---	---	---	15.60		9.50		7.25		8.39		16.3		20.5		5.92	
Total HxCDD	ng/kg	---	---	---	18.0		16.2		6.51		13.9		17.0		16.4		9.95	
Total HpCDF	ng/kg	---	---	---	27.2		28.4		20.5		24.6		36.7		33.1		13.4	
Total HpCDD	ng/kg	---	---	---	147		145		66.5		126		150		145		69.3	

Exceeds SL | Exceeds BT | Exceeds ML

‡ Value is normalized to TOC and expressed in mg/kg carbon

* Detection limit was based on the EMPC value

Validation Qualifiers (VQ):

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U The analyte was analyzed for but was not detected above the reported sample quantitation limit.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Table 5. Dioxin/Furan Congener Total TEQ Calculations

			DW20-DMMU1		DW20-DMMU2		DW20-DMMU3		DW20-DMMU4		DW20-DMMU5		DW20-DMMU6		DW20-ZLAYER-C	
Dioxins/Furans	Units	TEFs	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL
2,3,7,8-TCDF	ng/kg	0.1		0.01	0.026	0.026		0.007		0.0095	0.0308	0.0308	0.026	0.026		0.007
2,3,7,8-TCDD	ng/kg	1		0.08		0.07		0.06		0.065		0.06		0.06		0.06
1,2,3,7,8-PeCDF	ng/kg	0.03	0.0087	0.0087	0.0075	0.0075	0.00525	0.00525	0.00798	0.00798	0.01014	0.01014		0.00375	0.00594	0.00594
2,3,4,7,8-PeCDF	ng/kg	0.3	0.2202	0.2202	0.216	0.216		0.039	0.1728	0.1728		0.096	0.2415	0.2415		0.0405
1,2,3,7,8-PeCDD	ng/kg	1		0.155		0.185		0.08		0.15		0.195		0.13		0.1
1,2,3,4,7,8-HxCDF	ng/kg	0.1	0.123	0.123	0.0925	0.0925		0.0245	0.0923	0.0923		0.06	0.18	0.18	0.054	0.054
1,2,3,6,7,8-HxCDF	ng/kg	0.1	0.0529	0.0529		0.021	0.0297	0.0297	0.0524	0.0524		0.0215	0.06	0.06		0.015
2,3,4,6,7,8-HxCDF	ng/kg	0.1	0.157	0.157	0.146	0.146		0.04075	0.123	0.123	0.361	0.361	0.186	0.186		0.0235
1,2,3,7,8,9-HxCDF	ng/kg	0.1	0.0442	0.0442		0.009		0.0055	0.016	0.016		0.006	0.061	0.061		0.0095
1,2,3,4,7,8-HxCDD	ng/kg	0.1	0.0787	0.0787		0.0375		0.013		0.032		0.03		0.0265	0.038	0.038
1,2,3,6,7,8-HxCDD	ng/kg	0.1	0.285	0.285	0.234	0.234		0.05	0.187	0.187	0.225	0.225	0.251	0.251	0.168	0.168
1,2,3,7,8,9-HxCDD	ng/kg	0.1	0.181	0.181		0.07	0.0619	0.0619		0.06	0.176	0.176	0.15	0.15		0.033
1,2,3,4,6,7,8-HpCDF	ng/kg	0.01	0.092	0.092	0.0896	0.0896	0.0558	0.0558	0.0823	0.0823	0.118	0.118	0.106	0.106	0.0427	0.0427
1,2,3,4,7,8,9-HpCDF	ng/kg	0.01	0.00811	0.00811		0.00335		0.0026		0.0038	0.0112	0.0112	0.0109	0.0109	0.0046	0.0046
1,2,3,4,6,7,8-HpCDD	ng/kg	0.01	0.615	0.615	0.552	0.552	0.269	0.269	0.462	0.462	0.573	0.573	0.632	0.632	0.284	0.284
OCDF	ng/kg	0.0003	0.00867	0.00867	0.00972	0.00972	0.00804	0.00804	0.00828	0.00828	0.01068	0.01068	0.00888	0.00888	0.00417	0.00417
OCDD	ng/kg	0.0003	0.1593	0.1593	0.1533	0.1533	0.0693	0.0693	0.1233	0.1233	0.156	0.156	0.1626	0.1626	0.0696	0.0696
Total TEQ (ND = 0)	ng/kg		2.03		1.53		0.499		1.33		1.67		2.08		0.671	
Total TEQ (ND = 1/2 DL)	ng/kg			2.28		1.92		0.821		1.65		2.14		2.30		0.960

Detection limit was based on the EMPC value

Table 6. Puget Sound Sediment Reference Material (PSRM0129)

Analyte	True Value (ng/kg)	Result (ng/kg)	MDL	RL	Lab Qualifiers	PS-SRM % REC.	QC Limits % REC.
***Dioxins/Furans* (Sample ID: PSRM0129)**							
2,3,7,8-TCDF	1.11	ND	0.9	17	U		50 - 150
2,3,7,8-TCDD	1.05	ND	0.99	17	U		50 - 150
1,2,3,7,8-PeCDF	1.23	0.95	0.51	85	M,J,R	77.2	50 - 150
2,3,4,7,8-PeCDF	1.07	1.1	0.41	85	M,J,R	103	50 - 150
1,2,3,7,8-PeCDD	1.08	ND	0.92	85	U		50 - 150
1,2,3,4,7,8-HxCDF	3.02	2.3	1.1	85	J,R	76.2	50 - 150
1,2,3,6,7,8-HxCDF	1.09	ND	1.1	85	U		50 - 150
2,3,4,6,7,8-HxCDF	1.83	ND	1.1	85	U		50 - 150
1,2,3,7,8,9-HxCDF	0.511	1.3	1.2	85	J	254 *	50 - 150
1,2,3,4,7,8-HxCDD	1.59	ND	1.7	85	U		50 - 150
1,2,3,6,7,8-HxCDD	3.88	4.7	1.7	85	J	121	50 - 150
1,2,3,7,8,9-HxCDD	3.04	3.9	1.8	85	M,J,R	128	50 - 150
1,2,3,4,6,7,8-HpCDF	18.7	20.1	0.45	85	J	107	50 - 150
1,2,3,4,7,8,9-HpCDF	1.63	1	0.59	85	M,J,R	61.3	50 - 150
1,2,3,4,6,7,8-HpCDD	90.6	105	1.3	85		116	50 - 150
OCDF	58.4	61.7	0.85	170	J	106	50 - 150
OCDD	811	1080	2	170		133	50 - 150
***PCB Aroclor* (Sample ID: PSRM0129)**							
Aroclor 1260	108	115	2.1	10		132	38 - 167

Notes:
* Value outside of quality control (QC) limits
MDL Method detection limit
ND Not detected
RL Reporting limit
% REC. Percent recovery

Lab Qualifiers:
J The result is an estimated value below the reporting limit
M Indicates that a peak has been manually integrated
R Indicates that the ion abundance ratio for this compound did not meet the acceptance criterion
U The analyte was analyzed for, but was not detected ("non-detect") at or above the MRL/MDL

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4.0 QUALITY ASSURANCE AND QUALITY CONTROL

Herrera conducted EPA Level 2B review and validation of all DMMP chemistry data and EcoChem, Inc., conducted EPA Level 4 review and validation of the dioxin/furan congener results (Appendix D).

The Level 2B validation included evaluations of sample holding times, QC sample results, analytical methods, and calculation verification. Except where noted below, sediment QC results for conventional parameters, metals, and organics (PCBs, organochlorine pesticides, SVOCs, and dioxins/furans) were within the control limits prescribed either by the SAP, analytical methods, DMMP requirements, or by the laboratory.

- The relative percent difference (RPD) for the matrix spike/matrix spike duplicate (MS/MSD) analyses for antimony was outside of control for DW20-DMMU5. The post-spike sample was also outside of control and the result was qualified as estimated.
- Di-n-butyl phthalate was detected in the laboratory blank at a concentration between the MDL and RL. Reported results less than the RL were qualified as not detected. Reported results above the RL but less than 5 times the blank result were qualified as estimated.
- The Aroclor 1254 result for DW20-ZLAYER-C had a RPD value between the primary and confirmation column that exceeded 40 percent. The result was qualified as estimated.
- Hexachlorobutadiene was detected in the method blank above the MDL, but less than the RL. Detected sample results within the action level were qualified as not detected.

A summary of assigned Level 2B validation qualifiers is provided in Table 7.

EPA Level 4 full validation was performed on dioxin/furan congener results for sediment and QC sample data. The validation determined that the laboratory followed the specified analytical method. Overall, accuracy was acceptable as demonstrated by the labeled compound, reference material, and ongoing precision and recoveries (OPR). Precision was acceptable as indicated by the laboratory duplicate RPD values.

Dioxin/furan detection limits were elevated based on EMPC values. Results were estimated due to diphenyl ether interferences. A summary of assigned Level 4 validation qualifiers is provided in Table 7.

All samples submitted to the laboratory were analyzed, and one hundred percent completeness was achieved for DMMP characterization of all parameters. All data, as qualified, were considered usable for the purposes of this characterization.

Table 7. Data Qualified by EPA Level 2B and Level 4 Validation

Sample ID	Analyte	Result	Units	Lab Qualifier	Validation Qualifier
Level 2B Validation					
W20-DMMU5	Antimony	0.169	mg/kg		J
W20-DMMU1	Di-n-butyl phthalate	43	µg/kg		J
W20-DMMU2	Di-n-butyl phthalate	22	µg/kg	J	U
W20-DMMU3	Di-n-butyl phthalate	27	µg/kg	J	U
W20-DMMU4	Di-n-butyl phthalate	24	µg/kg	J	U
W20-DMMU5	Di-n-butyl phthalate	39	µg/kg	J	U
W20-DMMU6	Di-n-butyl phthalate	11	µg/kg	J	U
W20-ZLAYER-C	Aroclor 1254	26	µg/kg	P	J
W20-DMMU1	Hexachlorobutadiene	0.41	µg/kg	J,B	U
W20-DMMU2	Hexachlorobutadiene	0.41	µg/kg	J,B	U
W20-DMMU3	Hexachlorobutadiene	0.38	µg/kg	J,B	U
W20-DMMU5	Hexachlorobutadiene	0.43	µg/kg	J,B	U
W20-DMMU6	Hexachlorobutadiene	0.40	µg/kg	J,B	U
Level 4 Validation					
DW20-DMMU1	1,2,3,7,8-PeCDD	0.31	ng/kg	J,R	U
DW20-DMMU1	2,3,4,6,7,8-HxCDF	1.57	ng/kg	J	J
DW20-DMMU1	2,3,7,8-TCDF	0.2	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,4,7,8,9-HpCDF	0.67	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,4,7,8-HxCDD	0.75	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,6,7,8-HxCDF	0.42	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,7,8,9-HxCDD	1.4	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,7,8,9-HxCDF	0.18	ng/kg	M,J,R	U
DW20-DMMU2	1,2,3,7,8-PeCDD	0.37	ng/kg	M,J,R	U
DW20-DMMU2	2,3,4,6,7,8-HxCDF	1.46	ng/kg	J	J
DW20-DMMU3	1,2,3,4,7,8,9-HpCDF	0.52	ng/kg	J,R	U
DW20-DMMU3	1,2,3,4,7,8-HxCDD	0.26	ng/kg	M,J,R	U
DW20-DMMU3	1,2,3,4,7,8-HxCDF	0.49	ng/kg	J,R	U
DW20-DMMU3	1,2,3,6,7,8-HxCDD	1	ng/kg	M,J,R	U
DW20-DMMU3	1,2,3,7,8-PeCDD	0.16	ng/kg	M,J,R	U
DW20-DMMU3	2,3,4,6,7,8-HxCDF	0.815	ng/kg	M,J	J
DW20-DMMU3	2,3,4,7,8-PeCDF	0.26	ng/kg	M,J,R	U
DW20-DMMU4	1,2,3,4,7,8,9-HpCDF	0.76	ng/kg	M,J,R	U
DW20-DMMU4	1,2,3,4,7,8-HxCDD	0.64	ng/kg	M,J,R	U
DW20-DMMU4	1,2,3,7,8,9-HxCDD	1.2	ng/kg	M,J,R	U
DW20-DMMU4	1,2,3,7,8-PeCDD	0.3	ng/kg	M,J,R	U
DW20-DMMU4	2,3,4,6,7,8-HxCDF	1.23	ng/kg	M,J	J
DW20-DMMU4	2,3,7,8-TCDF	0.19	ng/kg	M,J,R	U
DW20-DMMU5	1,2,3,4,7,8-HxCDD	0.6	ng/kg	J,R	U
DW20-DMMU5	1,2,3,4,7,8-HxCDF	1.2	ng/kg	J,R	U
DW20-DMMU5	1,2,3,6,7,8-HxCDF	0.43	ng/kg	M,J,R	U
DW20-DMMU5	1,2,3,7,8-PeCDD	0.39	ng/kg	M,J,R	U
DW20-DMMU5	2,3,4,6,7,8-HxCDF	3.61	ng/kg	J	J
DW20-DMMU5	2,3,4,7,8-PeCDF	0.64	ng/kg	M,J,R	U
DW20-DMMU6	1,2,3,4,7,8-HxCDD	0.53	ng/kg	M,J,R	U
DW20-DMMU6	1,2,3,7,8-PeCDD	0.26	ng/kg	M,J,R	U
DW20-DMMU6	1,2,3,7,8-PeCDF	0.25	ng/kg	M,J,R	U

Sample ID	Analyte	Result	Units	Lab Qualifier	Validation Qualifier
DW20-DMMU6	2,3,4,6,7,8-HxCDF	1.86	ng/kg	J	J
DW20-ZLAYER-C	1,2,3,6,7,8-HxCDF	0.3	ng/kg	J,R	U
DW20-ZLAYER-C	1,2,3,7,8,9-HxCDD	0.66	ng/kg	M,J,R	U
DW20-ZLAYER-C	1,2,3,7,8-PeCDD	0.2	ng/kg	M,J,R	U
DW20-ZLAYER-C	2,3,4,6,7,8-HxCDF	0.47	ng/kg	M,J,R	UJ
DW20-ZLAYER-C	2,3,4,7,8-PeCDF	0.27	ng/kg	M,J,R	U

Lab Qualifiers:

B Indicates that this target was detected in the blank at greater than 10% of the sample concentration

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample

M Indicates that a peak has been manually integrated

R Indicates that the ion abundance ratio for this compound did not meet the acceptance criterion

Validation Qualifiers:

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample

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5.0 SUMMARY

The project depth for Duwamish Waterway Section B included the authorized project depth (–15 ft MLLW), two feet of overdepth (to –17 ft MLLW), plus the Z-layer (–17 to –19 ft MLLW).

Six DMMUs were analyzed for the full suite of DMMP conventional parameters and chemicals of concern, including dioxins/furans. A Z-layer composite sample was analyzed for total solids, TVS, TOC, PCBs, and dioxins/furans. Organochlorine pesticides were analyzed using EPA Method 1699 to achieve lower reporting limits. All data were considered complete and usable.

Chemistry results in all DMMUs were below the DMMP SLs, which suggested that the proposed dredged material was suitable for open-water disposal.

The Z-layer composite sample was also below the DMMP SLs for PCBs and dioxins/furans, which suggested that the new leave surface would comply with Washington State's antidegradation standard.

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6.0 REFERENCES

DMMP. 2009. Determination Regarding the Suitability of Federal Operation and Maintenance Dredged Material from the Duwamish River, Seattle, King County, Washington Evaluated under Section 404 of the Clean Water Act for Beneficial Use or Unconfined Open-Water Disposal at the Elliott Bay Nondispersive Site. Public Notice CENWS-OD-TS-NS-26. Dredged Material Management Program, October 15, 2009.

DMMP. 2018a. Determination Regarding the Suitability of Maintenance Dredged Material from the Duwamish River Navigation Channel Evaluated under Section 404 of the Clean Water Act for Unconfined Open-Water Disposal at the Elliott Bay Nondispersive Site. Dredged Material Management Program, May 24, 2018.

DMMP. 2018b. Dredged Material Evaluation and Disposal Procedures (Users' Manual). Prepared by the Dredged Material Management Office, U.S. Army Corps of Engineers, Seattle District. December 2018.

NewFields. 2020. Duwamish Waterway Section B Dredged Material Characterization, Seattle, Washington. Sampling and Analysis Plan. Final. December 5, 2020. Prepared for U.S. Army Corps of Engineers, Seattle District. Prepared by NewFields Government Services, Edmonds, WA.

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APPENDIX A: SAMPLING AND ANALYSIS PLAN

APPENDIX B: FIELD LOGS AND PHOTOGRAPHS

(ELECTRONIC COPY ONLY)

APPENDIX C: LABORATORY DATA REPORTS AND CHAIN OF CUSTODY FORMS

(ELECTRONIC COPY ONLY)

APPENDIX D: EPA LEVEL 2B AND LEVEL 4 DATA VALIDATION

APPENDIX E: ENVIRONMENTAL INFORMATION MANAGEMENT DATABASE
(ELECTRONIC COPY ONLY)

APPENDIX F: GEODATABASE FILES
(ELECTRONIC COPY ONLY)